

**REMARKS**

Applicants acknowledge receipt of an Office Action dated February 2, 2006.

Claims 1-7 are pending in the application.

Reconsideration of the present application is respectfully requested in view of the remarks which follow.

**Drawing Objections**

On page 2 of the Office Action, the PTO has requested that Applicants furnish a drawing under 37 C.F.R. § 1.81. A formal drawing is being submitted herewith. In addition, Applicants have amended the specification to insert a brief description of the drawing and to refer to the reference numerals shown in the drawing.

**Rejections Under 35 U.S.C. § 103**

On page 2 of the Office Action, the PTO has rejected claims 1-7 under 35 U.S.C. § 103(a) as allegedly being unpatentable over U.S. Patent 6,715,693 to Dam et al. (hereafter "Dam"). In addition, on page 3 of the Office Action, the PTO has rejected claims 1-7 under 35 U.S.C. § 103(a) as allegedly being unpatentable over U.S. Patent 6,156,439 to Coffinberry. Applicants respectfully traverse these rejections for the reasons set forth below.

To establish *prima facie* obviousness of a claimed inventions, all the claim limitations must be taught or suggested by the prior art. *In re Vaeck*, 947 F.2d 488, 10 USPQ2d 1438 (Fed. Cir. 1991). See MPEP §2141.03.

Here, Applicants submit that neither Dam nor Coffinberry, taken either alone or in combination, teach or suggest "a surface roughness ( $R_y$ )( $\mu\text{m}$ ) which satisfies a relationship represented by the following formula (A):

$$R_y < (0.75 - H_k/8000) \times h + 0.0875 \dots (A)$$

where h is the thickness ( $\mu\text{m}$ ) of the hard carbon thin film; and Hk is the surface hardness in Knoop hardness ( $\text{kg/mm}^2$ ) of the hard carbon thin film" as recited in independent claim 1.

With the above referenced relationship, the hard carbon thin film is suitably controlled in its surface roughness or shape in accordance with the surface hardness and the film thickness. Therefore, the hard carbon thin film effectively avoids cracking, peeling-off and

the like which tend to occur when other hard carbon thin films are applied to a sliding section of a fuel injection valve of an automotive vehicle. As a result, the fuel injection valve exhibits durability reliability, a low friction coefficient and improved seizure resistance and also improved response characteristics under the realized low coefficient of friction.

In the fuel injection valve according to the presently claimed invention, a force input condition of load allowable by the hard carbon thin film is determined in accordance with the thickness and hardness of the hard carbon thin film, particularly of the DLC thin film as recited in dependent claim 5. Accordingly, by suitably regulating factors such as the surface roughness, shape and the like of the hard carbon thin film relative to sliding conditions at the given film and the section to which the film is applied, the force input condition is limited within a certain range, so that the film can avoid the formation of cracks and peeling-off at the section to which the film is applied, while maintaining its function as a film for a long time.

Thus, the presently claimed invention: (a) provides an improved fuel injection valve which can ensure its durability reliability, realize a low friction coefficient and exhibit improved seizure resistance while also exhibiting improved response characteristics under the realized low friction coefficient; and (b) provide an improved fuel injection valve whose sliding section is coated with a hard carbon thin film, in which the hard carbon thin film can be effectively prevented from forming crack, peeling-off and the like which occur when the hard carbon thin film which is generally seemed to be low in ductility is applied to the sliding section because it is extremely high in hardness as compared with a film formed by a surface treatment such as plating or the like.

With particular regard to Dam, Applicants note that Dam describes a metal carbon thin film which has a surface hardness of greater than  $1000 \text{ kg/mm}^2$ , and a film thickness desirably no greater than about 2.0 microns. Dam fails to teach or suggest the relationship set forth in formula “(A)” described above.

With particular regard to Coffinberry, Applicants note that Coffinberry describes a hard carbon thin film. Coffinberry, however, fails to teach or suggest the relationship set forth in formula “(A)” above.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the outstanding rejections under 35 U.S.C. §103.

**CONCLUSION**

In view of the foregoing amendments and remarks, Applicants respectfully submit that all of the pending claims are now in condition for allowance. An early notice to this effect is earnestly solicited. If there are any questions regarding the application, the Examiner is invited to contact the undersigned at the number below.

Respectfully submitted,

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The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check or credit card payment form being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicants hereby petition for such extension under 37 C.F.R. §1.136 and authorize payment of any such extensions fees to Deposit Account No. 19-0741.